Sanitary Sewer Overflow Analysis and Planning (SSOAP) Toolbox

Fu-hsiung (Dennis) Lai[1], Srinivas Vallabhaneni[2], Carl Chan[2], Richard Field[1], Edward H. Burgess[2] • [1]U.S. Environmental Protection Agency, National Risk Management Research Laboratory, Water Supply and Water Resources Division, Urban Watershed Management Branch, Edison, NJ • [2]Camp Dresser & McKee, Inc.

The Issue

Rainfall Dependent Inflow and Infiltration (RDII) into sanitary sewer systems has long been recognized as a source of operating problems in sewerage systems. RDII is the main cause of sanitary sewer overflows (SSOs) to basements, streets, or nearby streams. RDII can also cause serious operating problems at wastewater treatment facilities. Thus, there is a need to develop proven methodologies and computer tools to assist SSO communities in developing an optimal capital improvement program that is in line with the projected annual capital budget and provides flexibility in future improvements.

Abstract

The Nation's sanitary sewer infrastructure is aging, with some sewers dating back over 100 years. Nationwide, there are more than 19,500 sanitary sewer collection systems serving an estimated 150 million people and about 40,000 SSO events per year. Because of potential health and environmental risks associated with SSOs, USEPA has plans to add control and mitigation of SSOs to the existing National Pollutant Discharge Elimination System permit requirements. The proposed Capacity, Management, Operation, and Maintenance (CMOM) program is being widely accepted by sanitary sewer communities.

To assist SSO communities in developing SSO mitigation plans, USEPA signed a cooperative research and development agreement (CRADA) in 2002 with Camp, Dresser, and McKee (CDM) to develop a public domain computer analysis and modeling toolbox. This CRADA will also prepare a technical guide for performing capacity analysis of a sanitary sewer system and developing a SSO control plan using the toolbox.

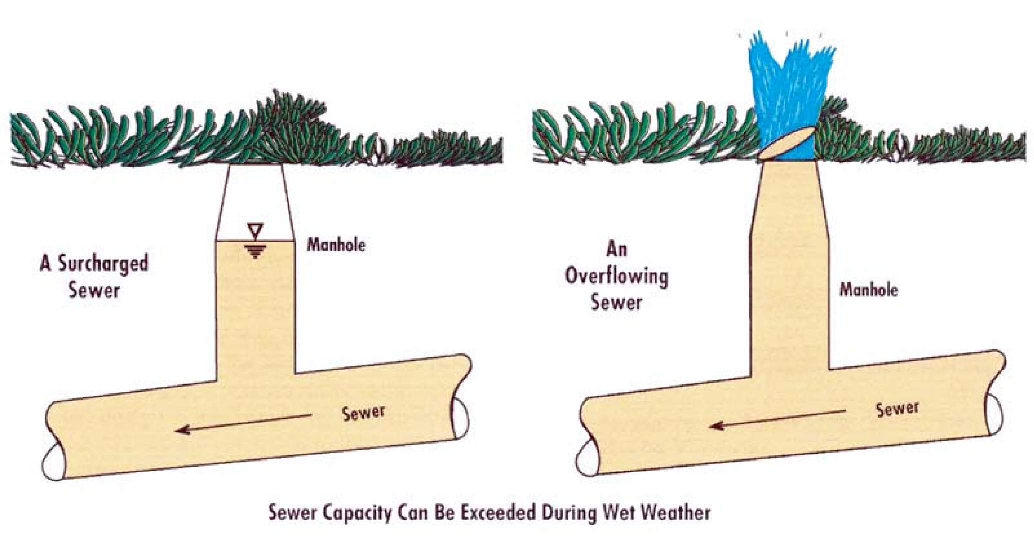
Objectives

- Review RDII prediction methods.
- Develop computer tools and prepare technical documents for SSO communities to perform SSO analysis and develop SSO mitigation plans.

Background

National wastewater infrastructures are deteriorating

- The 2005 ASCE infrastructure report gave the wastewater category a D? grade down from a D in the 2001 report.
- Nationally, an estimated 50,000 sewer breaks and 500,000 stoppages occur yearly and about 75% of the nation's piping systems are functioning at 50% capacity or less.



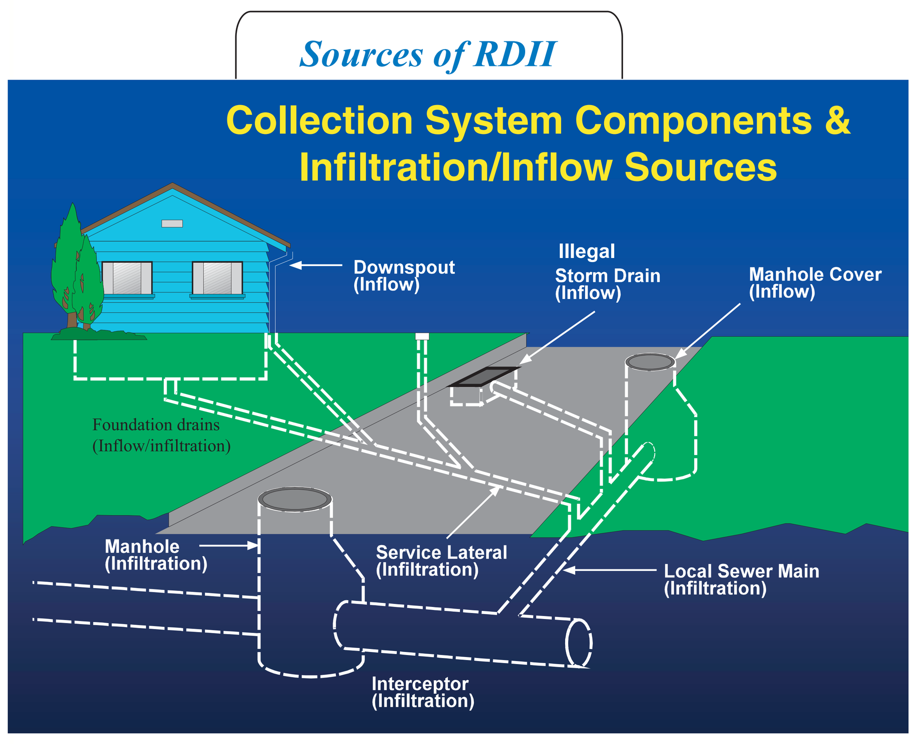
Causes of SSOs

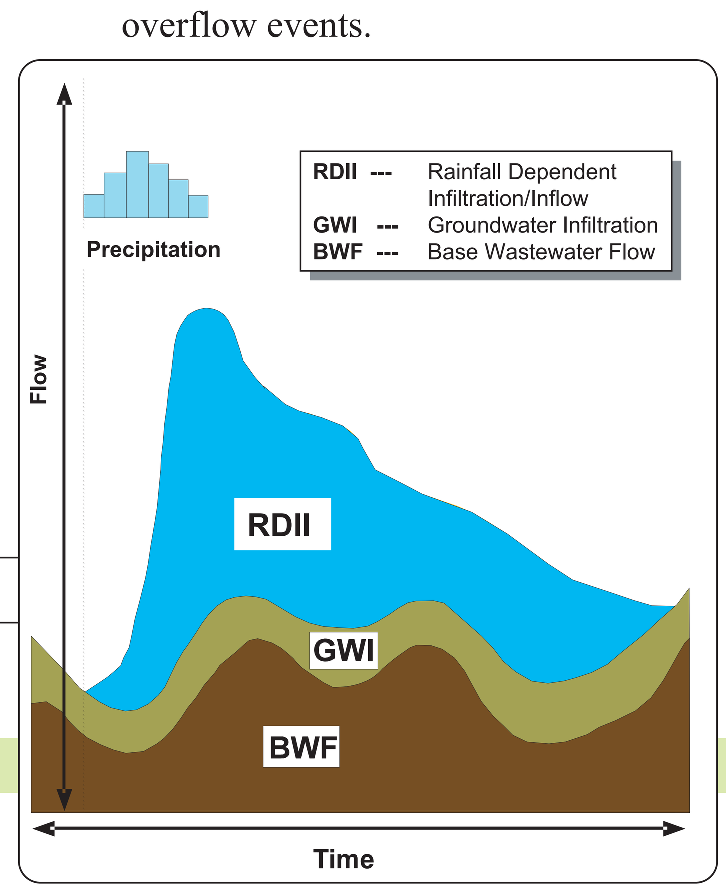
- Excessive RDII deprives sewer carrying capacity causing sewer surcharge and overflows.
- Sewer blockages from root intrusion, grease build-up, sedimentation, and debris.

The CMOM program

- Properly operate and maintain all parts of the collection system.
- Provide adequate conveyance capacity for base and peak flows.
- Take all feasible steps to stop and mitigate the impact of SSOs.
- Provide public notification of overflow events.

Sources of RDII





Components of wet-weather wastewater flow

Approach

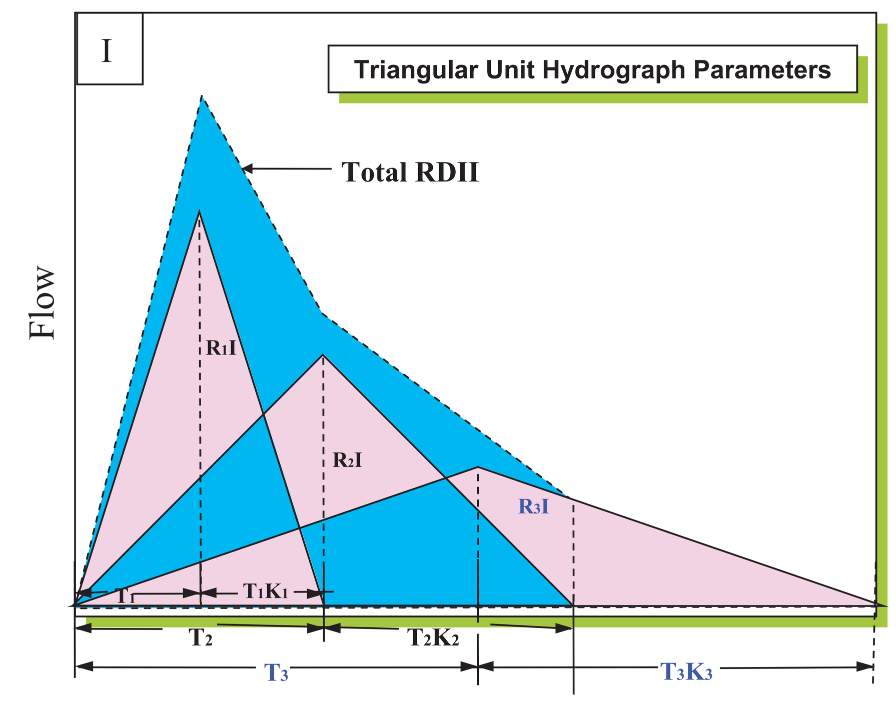
RDII Prediction Methods

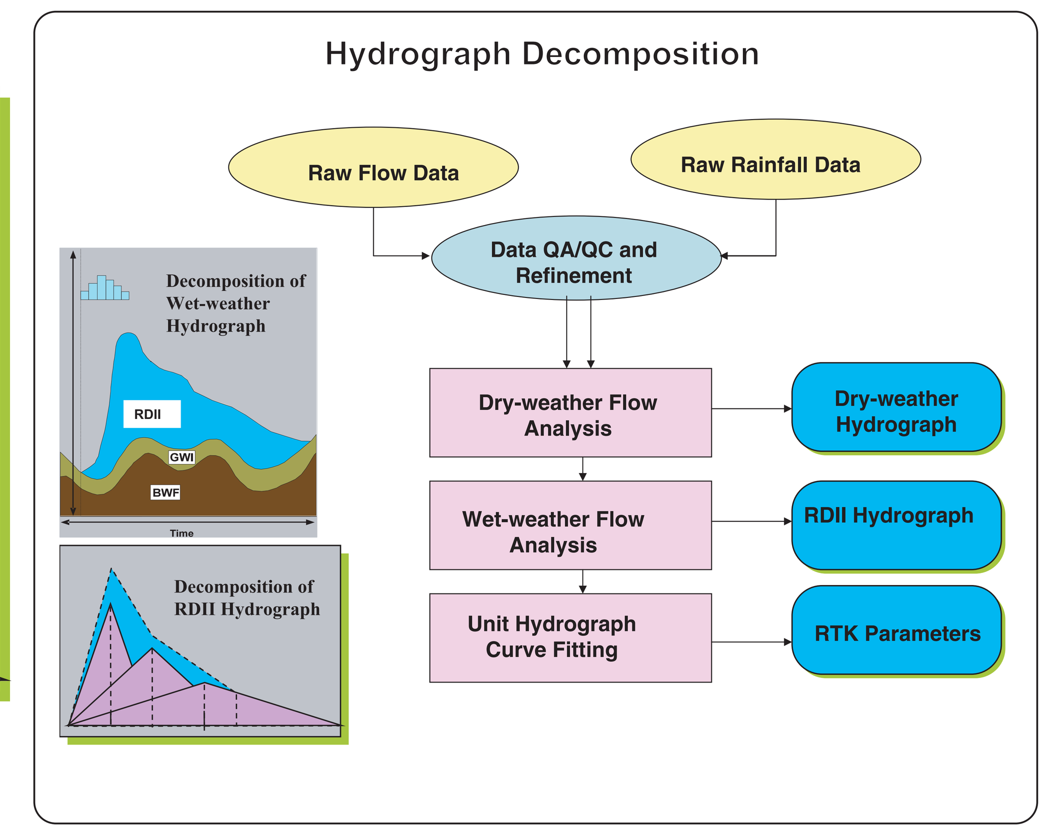
A Water Environment Research Foundation (WERF) report (Bennett et al. 1999) evolved in eight broad categories of RDII prediction methods that were evaluated.
The report concluded that the synthetic unit hydrograph (SUH) and rainfall/flow regression were the two most accurate methods at predicting peak flows and event volumes.

The "RTK" method, as used in the USEPA Stormwater Management Model (SWMM) Version 4 (Huber et al.1988) and Version 5 (SWMM5) (USEPA 2004), is probably the most popular SUH method. This method uses up to three triangular unit hydrographs shown below to estimate the fast, medium, and slow RDII responses. The R parameter is the fraction of rainfall volume entering the sewer system as RDII, T is the time to peak, and K is the ratio of time of recession to T.

While other RDII prediction methods could be included, the SSOAP toolbox from this CRADA will only include the unit hydrograph method.

Approach, continued

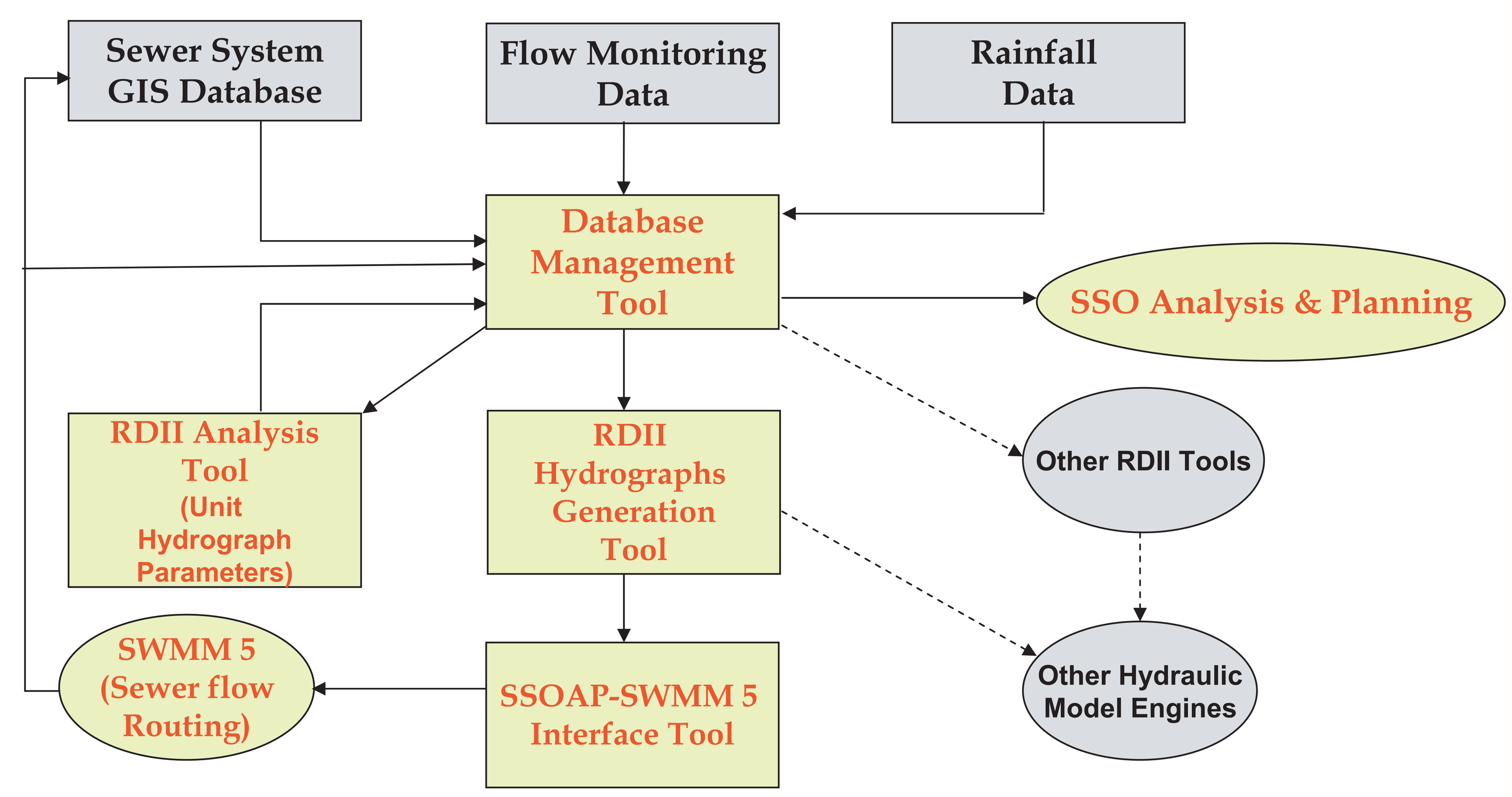




SSOAP Toolbox

The SSOAP toolbox integrates existing databases of a sanitary sewer system and contains five functional tools

Database management tool - serves as the command center of the toolbox. It provides interface with several data sources (sewer systems, flow, and rainfall data), and interacts with other SSOAP tools and exchanges data.



RDII analysis tool - performs wastewater hydrograph decomposition shown above and determines up to three sets of RDII parameters (R, T, and K).

RDII hydrograph generation tool - generates the RDII hydrograph of a sewershed for the selected rainfall events using its physical characteristics (e.g., sewer areas and land uses).

SWMM5 interface tool - incorporate the inflow hydrograph (RDII + DWF) for a sewershed into the SWMM5 input file.

SWMM5 - performs the actual dynamic flow routing through a sewer network system and uses the graphic utility interface capability in SWMM5 to visualize the sewer system responses and selectively exports the output data for further analysis.

Analysis and Planning Guide

In addition to user manuals for various tools in the toolbox, the guide will include the following step-by-step technical guidance for development of a capital improvement plan.

- This project demonstrates a collaborative effort of USEPA with a leading engineering firm to develop a sound risk management tool for planning and design of high cost SSO control.
- The toolbox will support USEPA program offices in adding the CMOM requirements to the NPDES permits to mitigate pollution from SSOs.

Bennet, D., et al. (1999). Using Flow Prediction Technologies to Control Sanitary Sewer Overflow, Water Environment Research Foundation (WERF), Project 97-CTS-8.
Huber, W.C., and Dickinson, R.E. (1988). Storm Water Management Model User's Manual, Version 4; EPA/600/3-88/001a. U.S. Environmental Protection Agency, Athens, GA.
U.S. Environmental Protection Agency (USEPA). (2004). Stormwater Management Model Redevelopment Project. http://www.epa.gov/ednnrmrl/swmm/index.htm.